CLAIMS

What is claimed is:

1. A targeting device for detecting a precise location and position within a hollow object having an opening, comprising:
   a. a magnet adapted to be positioned within the opening of the tube for providing a directional field, wherein the magnet includes a three-dimensional orientation on an x-axis, a y-axis and a z-axis; and
   b. a target device, including sensing means for identifying the magnet location along the three-dimensional orientation of the magnet; and a display means, wherein the display means represents the orientation of the sensing means.

2. The targeting device of claim 1 wherein the magnet includes the following characteristics: a) a magnetic field of sufficient strength to match the sensing means of the target device, b) a magnetic field of sufficient shape to provide the desired feedback necessary to discriminate targeting in all required planes.

3. The targeting device of claim 2 wherein the magnetic field is nonuniform.

4. The targeting device of claim 3 wherein the magnetic field is non-circular allowing the sensing means to distinguish rotation about the z-axis, while peak flux lines perpendicular from the magnet indicate its exact center.

5. The targeting device of claim 1 wherein the magnet is cylindrical in shape.

6. The targeting device of claim 1 wherein the magnet has a diameter less than about 4mm.

7. The targeting device of claim 1 wherein the magnet is a Neodymium Iron Boron (NdFeB) magnet that is polarized perpendicular to its long axis.

8. The targeting device of claim 1 wherein the sensing means comprises at least one sensor for detecting the magnetic flux lines of the magnet.

9. The targeting device of claim 1 wherein the sensing means comprises an array of sensors for detecting the magnetic flux lines of the magnet.

10. The targeting device of claim 1 wherein the sensing means comprise a readily readable display.

11. The targeting device of claim 1 wherein the sensing means comprises eight sensors in an elliptical array forming four pairs.

12. The targeting device of claim 11 wherein the sensors are arrayed in an elliptical pattern with the elements comprising four pairs opposing member elements, wherein the difference in output between pair members is relative to the spatial difference of each pair member from the target magnet.

13. The targeting device of claim 1 wherein the target device comprises a readable display by which the location of the array, in relation to the target magnet, is displayed.

14. The targeting device of claim 13 wherein the target device comprises a readable LED display wherein the readable LED display includes means to generate variable brightness such that the light deceases as the target sensor moves toward correct alignment.

15. The targeting device of claim 1 wherein the hollow object is an intramedullary nail for the internal fixation of long bones, wherein the intramedullary nail has a longitudinal opening and screw openings.

16. The targeting device of claim 15 wherein the screw openings are transverse interlocking screw openings.

17. The targeting device of claim 15 wherein the screw openings are oblique interlocking screw openings.

18. The targeting device of claim 15 further comprising at least one drill sleeve for receiving and aligning a drill bit on a interlocking transverse screw opening.

19. A method for detecting a precise location and position within a hollow object having an opening and an external surface, comprising:

a. inserting and positioning a magnet having a three-dimensional orientation in the opening of the object at a discrete position in the tube, wherein the magnet includes a three-dimensional orientation on an x-axis, a y-axis and a z-axis;

b. providing a target device external to the discrete position, wherein the targeting device comprises sensing means for identifying the magnet location and position along the three-dimensional orientation of the magnet and a display means indicating the position of the sensing means in relation to the magnet; and

c. moving the target device along the external surface location until the sensing means senses the three-dimensional orientation of the magnet.

20. The method of claim 19 wherein the target device comprises at least one drill sleeve having an axis for positioning at the concealed location wherein the at least one drill sleeve is positioned at the concealed location.

21. The targeting device of claim 19 wherein the magnetic field is nonuniform.

22. The targeting device of claim 19 wherein the magnetic field is non-circular allowing the sensing means to distinguish rotation about the z-axis, while peak flux lines perpendicular from the magnet indicate its exact center.

23. The targeting device of claim 19 wherein the magnet is cylindrical in shape.

24. The targeting device of claim 19 wherein the magnet has a diameter less than about 4mm.

25. The targeting device of claim 19 wherein the magnet is a Neodymium Iron Boron (NdFeB) magnet that is polarized perpendicular to its long

axis.

26. The targeting device of claim 19 wherein the sensing means comprises at least one sensor for detecting the magnetic flux lines of the magnet.

27. The targeting device of claim 19 wherein the sensing means comprises an array of sensors for detecting the magnetic flux lines of the magnet.

28. The targeting device of claim 19 wherein the sensing means comprise a readily readable display.

29. The targeting device of claim 19 wherein the sensing means comprises eight sensors in an elliptical array forming four pairs.

30. The targeting device of claim 29 wherein the sensors are arrayed in an elliptical pattern with the elements comprising four pairs opposing member elements, wherein the difference in output between pair members is relative to the spatial difference of each pair member from the target magnet.

31. The targeting device of claim 19 wherein the target device comprises a readable display by which the location of the array, in relation to the target magnet, is displayed.

32. The targeting device of claim 31 wherein the target device comprises a readable LED display wherein the readable LED display includes means to generate variable brightness such that the light deceases as the target sensor moves toward correct alignment.

33. The targeting device of claim 19 wherein the hollow object is an intramedullary nail for the internal fixation of long bones, wherein the intramedullary nail has a longitudinal opening and screw openings.

34. A targeting device for percutaneously detecting the location and position of screw openings within an intramedullary nail for the internal fixation of long bones, wherein the intramedullary nail has a longitudinal opening and screw openings, comprising:

a. a magnet adapted to be positioned within the longitudinal opening of the intramedullary nail for providing a directional field, wherein the magnet includes a three-dimensional orientation on an x-axis, a y-axis and a z-axis; and

b. a target device, including sensing means for identifying the magnet location along the three-dimensional orientation of the magnet; and a display means, wherein the display means represents the orientation of the sensing means.

35. The targeting device of claim 34 wherein the screw openings are transverse interlocking screw openings

36. The targeting device of claim 34 wherein the screw openings are oblique interlocking screw openings

37. The targeting device of claim 34 further comprising at least one drill sleeve for receiving and aligning a drill bit on a interlocking transverse screw opening.

38. The targeting device of claim 34 wherein the intramedullary nail comprises a first and a second transverse screw opening.

39. The targeting device of claim 37 further comprising two drill sleeves for receiving and aligning a drill bit on each of the first and second transverse screw openings.

40. The targeting device of claim 34 wherein the magnet is fixedly positioned within the cavity of the intramedullary nail at a discrete position adjacent to the transverse interlocking screw opening.

41. The targeting device of claim 34 wherein the magnet is positioned at the end of an insertion rod for positioning within the cavity of the intramedullary nail to a discrete position proximal to the transverse interlocking screw opening.

42. The targeting device of claim 34 wherein the magnet includes the following characteristics: a) a flux field sufficient to match the sensing means of the target device, b) a flux field sufficient to provide the desired feedback necessary to discriminate targeting in all required planes.

43. The targeting device of claim 34 wherein the magnetic field is non-uniform.

44. The targeting device of claim 43 wherein the magnetic field is distinguishable to the sensing means at a distance of about 10 cm.

45. The targeting device of claim 34 wherein the magnet is cylindrical in shape, with a diameter of LEDs than about 4mm

46. The targeting device of claim 34 wherein the magnet is a cylindrical Neodymium Iron Boron (NdFeB) magnet that is polarized perpendicular to its long axis.

47. The targeting device of claim 34 wherein the sensing means comprises at least one sensor for detecting the magnetic flux lines of the magnet.

48. The targeting device of claim 34 wherein the sensing means comprises at least one pair of sensors.

49. The targeting device of claim 34 wherein the sensing means comprise a readily readable display.

50. The targeting device of claim 37 comprising a handle holding the sensing means and a drill sleeve.

51. The targeting device of claim 39 comprising a handle holding the sensing means and the drill sleeves.

52. The targeting device of claim 34 wherein the sensing means comprises eight sensors in an elliptical array forming four pairs.

53. The targeting device of claim 52 wherein the sensors are arrayed in an elliptical pattern with the elements comprising four pairs opposing member elements, wherein the difference in output between pair members is relative to the spatial difference of each pair member from the target magnet.

54. The targeting device of claim 34 wherein the target device comprises a

readable LED display by which the location of the array, in relation to the target magnet, is displayed.

55. The targeting device of claim 34 wherein the readable LED display includes means to generate variable brightness such that the light deceases as the target sensor moves toward correct alignment.

56. A method for detecting the location and position of interlocking transverse screw openings within an intramedullary nail for the internal fixation of long bones, wherein the intramedullary nail includes a longitudinal opening and interlocking screw openings, comprising:

a. inserting and positioning a magnet having a three-dimensional orientation in the opening of the intramedullary nail to a discrete position proximal to the transverse interlocking screw opening;

b. providing a targeting device external to the discrete position, wherein the targeting device comprises sensing means for identifying the magnet location along the three-dimensional orientation of the magnet and a display means indicating the position of the sensing means in relation to the magnet; and

c. moving the target device along the external surface location until the sensing means senses the three-dimensional orientation of the magnet.

57. The method of claim 56 wherein the target device comprises at least one drill sleeve having an axis for positioning at the concealed location wherein the at least one drill sleeve is positioned at the concealed

location.

58. The method of claim 56 comprising aligning the sensing means with the magnet and the screw opening while simultaneously and in real time monitoring the position of the drill sleeve in relation to the transverse interlocking screw opening.

59. The method of claim 57 comprising advancing a drill bit through each of the at least one drill sleeves and through the bone while maintaining alignment in real time.

60. The method of claim 56 comprising attaching the magnet to an insertion rod.

61. The method of claim 60 comprising inserting the insertion rod into the opening of the intramedullary nail in a specified orientation to a locking point at the most distal transverse interlocking screw opening.

62. The method of claim 56 comprising placing the magnet in the intramedullary nail at a point proximal to the targeted transverse interlocking screw opening.

63. The method of claim 56 comprising fixing the depth of the magnet with a locking pin.

64. The method of claim 56 comprising applying the target device percutaneously to the approximate region of the interlocking screw opening.

65. The method of claim 56 comprising detecting magnetic flux lines of the magnet to identify the magnet location.

66. The method of claim 56 wherein the interlocking screw opening is a transverse interlocking screw opening.